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Radical-Involved Asymmetric Additions via Chromium Catalysis

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Title: Radical-Involved Asymmetric Additions via Chromium Catalysis

Abstract:

The Stereoselective addition to carbon-carbon and carbon-heteroatom double bonds remains a cornerstone of asymmetric synthesis. However, conventional strategies predominantly rely on two-electron polar mechanisms, which are frequently constrained by the limited availability of chiral organometallic nucleophiles and the narrow chemical space accessible for vicinal stereocenter construction. To overcome these challenges, we have harnessed the unique oxophilicity and single-electron transfer capabilities of chromium to develop two innovative classes of stereoselective addition reactions: (1) Cr-catalyzed asymmetric carbonyl additions utilizing modular alkyl radical precursors, effectively bypassing the need for pre-functionalized organometallic reagents; and (2) Cr-catalyzed asymmetric cyclopropanation of non-stabilized carbenes. Our mechanistic dissections reveal a bifurcated stereocontrol model for carbonyl additions, progressing through either a rigid six-membered cyclic transition state or an outer-sphere acyclic radical addition pathway depending largely on the radical structure. Furthermore, we demonstrate that Cr-based metalloradical catalysis enables the highly diastereo- and enantioselective transformation of *gem*-dihaloalkanes. These findings underscore the potential of Earth-abundant transition metals to provide sustainable, highly selective solutions for the synthesis of complex, value-added chiral architectures.

Biography:

Dr. Zhaobin Wang earned his B.S. degree from Nanjing University in 2011 and completed his Ph.D. in 2015 at the Hong Kong University of Science and Technology under the guidance of Professor Jianwei Sun. In 2016, he joined the California Institute of Technology (Caltech) as a postdoctoral scholar in the laboratory of Professor Gregory C. Fu. Building upon this rigorous training, Dr. Wang began his independent academic career in October 2019 as an Assistant Professor in the School of Science at Westlake University, and was promoted to tenured Associate Professor in July 2025. Research in the Wang laboratory is dedicated to advancing Earth-abundant transition-metal catalysis with an emphasis on radical-involved asymmetric reactions. His group focuses on developing sustainable synthetic methodologies that deliver exceptional efficiency and stringent stereocontrol. In recognition of his scientific contributions, Dr. Wang was selected for the Young Thousand Talents Program in 2019 and is a recipient of the 2023 Thieme Chemistry Journals Award.